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THE TEXAS COMPANY

REFINING DEPARTMENT
TECHNICAL & RESEARCH DIVISION

REPORT ON

EUROPEAN ACTIVITIES

relating to

GAS TURBINES AND JET ENGINES

Contract No. [illegible]
Project No. NR220-018

Laboratory Special
Report No. Technical Report No. 3
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EUROPEAN ACTIVITIES RELATING TO GAS TURBINES AND DIESEL ENGINES

Contract No. N7onr-453

Project No. NR220-018

Special Technical Report

Report Prepared by:

The Texas Company

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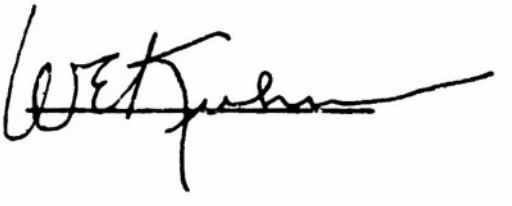

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INTRODUCTION

In the course of a general survey of technical developments in Europe during the fall and winter of 1951-52 by a representative of The Texas Company, a number of inquiries were made regarding activities which might bear on the study of jet combustion which is being carried out at the Beacon Laboratories of The Texas Company under Contract No. N7onr-453, Project No. NR-220-018. By courtesy of the Office of Naval Research the investigator was given an appointment as U. S. Navy Technician with the thought that such an appointment might facilitate collecting useful information. The present report has been prepared in fulfillment of the agreement in connection with this appointment.

The information given in this report is of necessity rather general since it was collected as only one part of a broad investigation which was conducted within a relatively short period of time. Furthermore, in some cases the nature of the work was such that the parties responsible for it were not free or not willing to discuss it in great detail. However, it is probable that duly qualified representatives of the Office of Naval Research could obtain more details about most of the projects if they care to communicate directly with the organization involved. Any additional information which the author may have relating to any of these projects will be furnished on request.

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This is the third in a series of reports of the same general nature. The two preceding reports were dated February 15, 1949 and December 13, 1950. As was also the case on previous trips the assistance of the Office of Naval Research in London was very effective in facilitating the acquisition of some of the information contained in these reports and was very much appreciated.

GAS TURBINES

The aircraft gas turbine division of Rolls Royce in England anticipates no trouble in designing combustors to avoid deposit trouble with any kind of distillate fuel that is likely to be used but stressed the importance of atomizers which will not accumulate carbon since flame distortion is highly objectionable. For civilian (turbo prop) air transport Rolls Royce feels that the kerosine type fuel is preferable for reasons of safety. It is believed that trouble with water freezing out of the fuel will be more serious than pour point and a solution of the filter icing problem is badly needed. Rolls Royce feels that synthetic lubricating oils are already needed for gas turbines.

The Joseph Lucas Company of Burnley, England, manufacturers of burners for gas turbines, feels that combustion efficiency depends more on the physical properties than on the chemical composition of fuels. Degree of atomization is particularly important and the method of introducing air to sweep any surfaces on which carbon might tend to deposit is also important. No additives have been found which improve atomization or combustion

efficiency. For the Parsons stationary or marine gas turbines, Lucas builds combustors of relatively large volume which operate satisfactory on residual fuels.

Under contract with the British Ministry of Fuel and Power, the Joseph Lucas Company has recently built a unit for the slagging gasification of powdered coal in a cyclone chamber to make fuel gas for gas turbines. This is designed for operation up to 6 atmospheres pressure but otherwise is similar in principle to units being investigated by Ruhrgas and B.C.U.R.A.

Armstrong Siddeley of Coventry, England anticipates no trouble with deposits from fuel in either their Mamba (turbo prop) or Sapphire (turbo jet) engines. Corrosion of the vaporizer in the Mamba burner is still a problem but these engines will be restricted to civilian transport service. Armstrong Siddeley is strongly in favor of synthetic lubricating oils for their aircraft gas turbines.

The British Ministry of Supply is particularly concerned about the storage stability of jet fuels because of the desirability of stock-piling fuel in England, and feels that composition would be determined more by this necessity than by carbon forming tendencies in the burner.

The Swiss firm of Brown Boveri feels that deposits in stationary gas turbines will be most serious if the melting point of the ash in the fuel is about the same as blade temperatures. If ash concentration can not be sufficiently low the ash melting point should be high. The addition of nickel has

been observed to raise the ash melting point but may not be sufficiently effective as turbine operating temperatures are raised. Sulfur in turbine fuel oils does not appear to contribute to blade deposits. Steam turbine oils have proved satisfactory so far for lubricating gas turbines but foaming is somewhat of a problem.

The Swiss firm Escher Wyss builds a closed cycle stationary gas turbine of which the first unit has been installed recently at a power station in St. Denis, France. The fuel problem appears to be no more serious than in conventional steam boilers and the lubrication problem is similar to that of steam turbines.

The Swiss firm Oerlikon builds small open cycle gas turbines for stationary power generation. One, now under construction, must operate on Bunker C fuel and Oerlikon is not sure what ash limit should be specified. Oerlikon has made extensive studies of burner design for gas turbines but offered no details regarding results of these studies.

Two stationary gas turbine units built by Sulzer Brothers in Switzerland have given trouble with blade deposits when operated on heavy fuel. Similar turbines are being designed for temperatures above 700°C where it is expected that the deposit problem will be serious unless fuels of very low ash content are used. Sulzer has developed a bench test for determining deposit forming tendencies of fuels and is studying fuel additives to solve this problem but no details of the

test or results were offered. Sulzer has no lubrication problem in connection with gas turbines.

The French firm of Rateau is studying the effect of fuel combustion on gas turbine deposits in a 12,000 hp unit of their own construction. Rateau is cooperating with Pescara in the development of free piston Diesel engines for use as gas generators for gas turbines. Rateau also builds aircraft turbines under license from Rolls Royce and is developing a turbine of French design which promises to have good fuel economy.

At Imperial College in London research is in progress on the ignitability and combustibility of oil sprays having uniform predetermined drop size. This work is just getting started but should yield data of great value in connection with spray combustion problems in general.

The British Coal Utilization Research Association is studying the combustion of coal in a cyclong burner in conjunction with a gas turbine. Photographic studies of dust entrainment in the combustion gases indicate that a separator similar to that developed by Yellot of Bituminous Coal Research may be most effective.

Research conducted in the laboratories of Imperial College in London shows that mine ventilation gases containing low concentrations of methane can be caused to ignite by heating to about 1000°C under pressure, which would permit such gas to be used as the fuel for a gas turbine.

The German firm MAN is continuing research on ceramic blades for gas turbines with encouraging results. No details have been published.

DIESEL ENGINES

The German firm MAN is making good progress in the design and construction of high efficiency high output supercharged Diesel engines. They are also making extensive studies of the combustion of heavy Diesel fuels in marine engines.

Sulzer is making studies of combustion of high sulfur residual fuel in a 22" single cylinder, two cycle Diesel engine in their laboratory near Zurich, Switzerland, which should yield useful data on the effect of sulfur on engine deposits. Sulzer has also developed improved nozzles for the injection of residual fuels.

The wear of liners in low speed marine Diesel engines has been reduced markedly by the addition of aniline to the lubricating oil which apparently originated with Burmeister and Wain of Copenhagen. There are obvious objections to this practice but the effectiveness of aniline suggests that other similar but less dangerous compounds may be found for the same purpose.

The Diesel engine passenger automobile introduced by Daimler Benz of Stuttgart, Germany, about three years ago is proving quite satisfactory and popular in Europe. No fuel or lubrication problems have been encountered. The engine is noisy when idling but research to correct this defect is now in progress.

MISCELLANEOUS

The OEEC with headquarters in Paris has been surveying the research needs of various member countries with the hope that means of better meeting these needs may be developed to contribute to the economic development of the countries in question. OEEC is also sponsoring cooperative research projects on problems in which several European countries may have a mutual interest. Such research on the low shaft blast furnace is underway in Liege, Belgium, and a proposal to study powdered coal gasification is being considered.

The Italian firm SICS has developed a new process for drying lignite by direct contact with hot oil and plans to build a commercial unit in Yugoslavia. This appears to be similar to work done independently by the U. S. Bureau of Mines in this country.

A new technique for drying peat has been developed by Prof. Terres at the Technische Hochschule in Karlsruhe, Germany. This involves moderate heating in water suspension which destroys the colloidal structure of peat and permits filtration to relatively low water content. The process is also applicable to the drying of lignite and therefore may prove interesting in the United States.

Calvo Sotelo is building Westwood retorts in a new plant for processing oil shale at Puertollano, Spain. It is planned eventually to process 1,200,000 tons of shale per day to produce 133,000 tons of liquid products per year. Primary refining will be by hydrogenation.

Dr. Koelbel of Rheinpreussen at Homberg, Germany is still studying hydrocarbon synthesis with a slurry catalyst and is now building a pilot plant having a capacity of two thousand cubic meters per hour. Koelbel has also developed a catalyst for making oil from carbon monoxide and steam. This process has received wide publicity but so far has been tried on only a small scale.

Koelbel is also reported to have developed a variation of the slurry synthesis in which heavy oil is recycled and converted to lighter products. Apparently this involves a special catalyst and has been tried only on a small scale.

There seems to be serious interest in the development of a synthetic fuel industry based on coal in the Belgian Congo. Prof. Mertens of the University of Louvain and engineers of the Belgian firm of Carbochimique and Union Chimique Belge are concerned with this possibility. Union Chimique Belge has given serious consideration to proposals from Lurgi and Ruhrchemie for the synthetic fuel plant in the Belgian Congo but apparently has not discussed this problem with Hydrocarbon Research.

Calvo Sotelo contemplates hydrocarbon synthesis units at their plants in Escatron and Puertollano, Spain, but at present favor the Lurgi-Ruhrchemie fixed bed technique. However, the construction of these units appears to be some years in the future.

In low temperature laboratories at Imperial College in London fundamental studies are being made of the properties of the oxygen-nitrogen-argon system which includes studies of

heat transfer to boiling liquids and from condensed vapors of mixtures of these elements. The resulting information may be useful in connection with the design of oxygen plants.

In the laboratories of the Gas Research Board near London studies are continuing on the vibratory combustion of gas but only for the purpose of attaining very high rates of heat release rather than for the production of synthesis gas. Studies are being started on the kinetics of the oxidation of hydrogen and carbon monoxide at atmospheric pressure but these may not be carried to completion because of the prospective closing of these laboratories.

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